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(54) **A method for dispersion**

(57) A method and apparatus for mixing and dispersing liquid or solid particles in a different liquid whereby a flow of the said different liquid is caused to collide with a flow of the first liquid or a liquid containing said solid particles.

FIG. 1

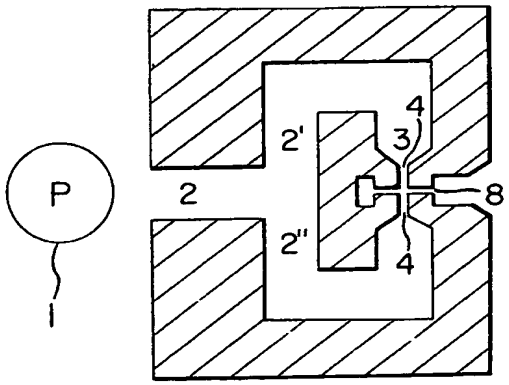

FIG. 2

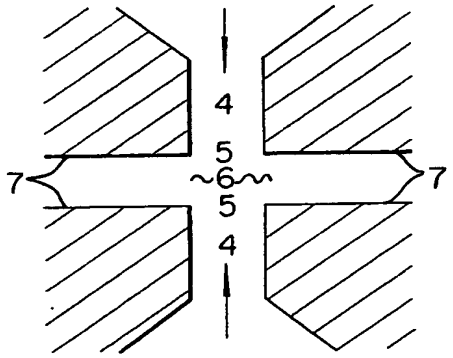

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FIG. 2

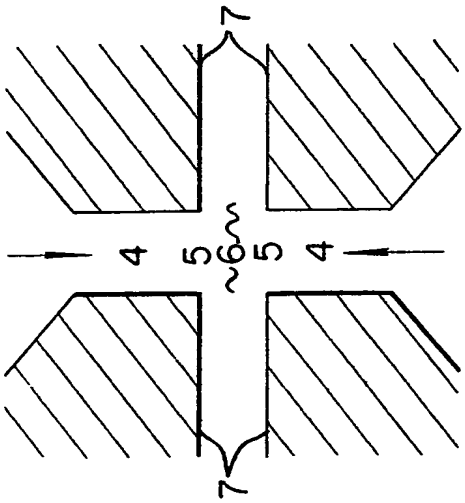


FIG. 4

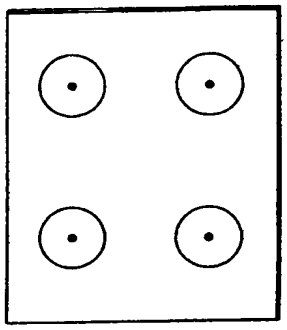


FIG. 1

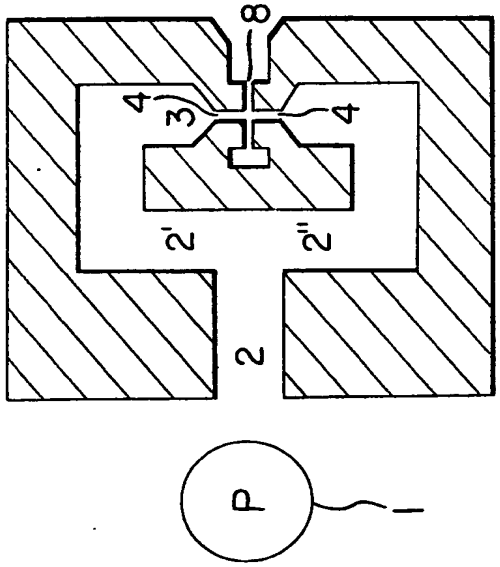


FIG. 3

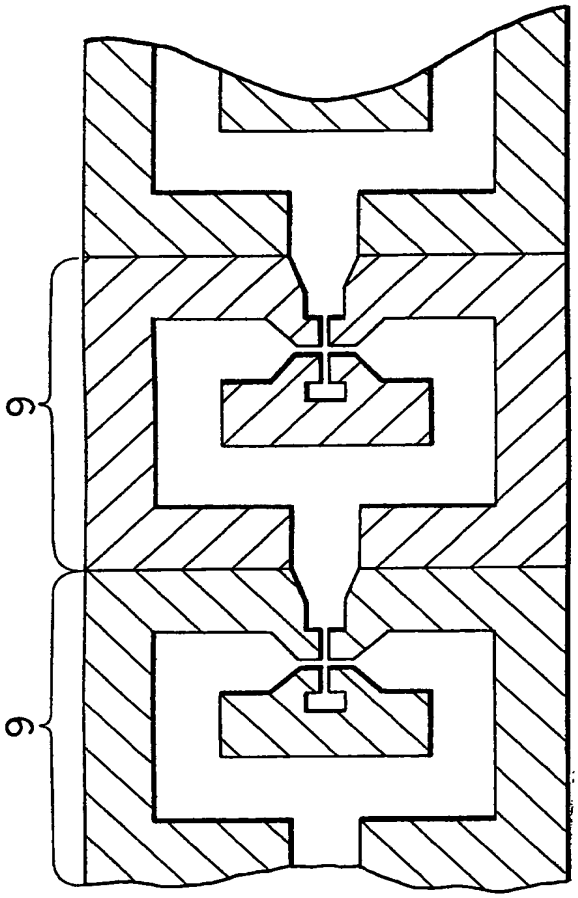


FIG. 5

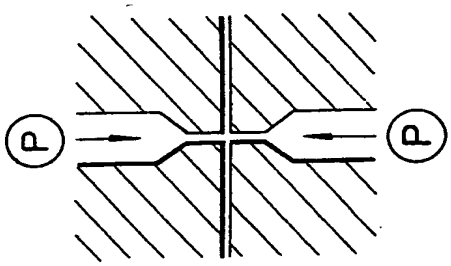


FIG. 6

FIG. 7

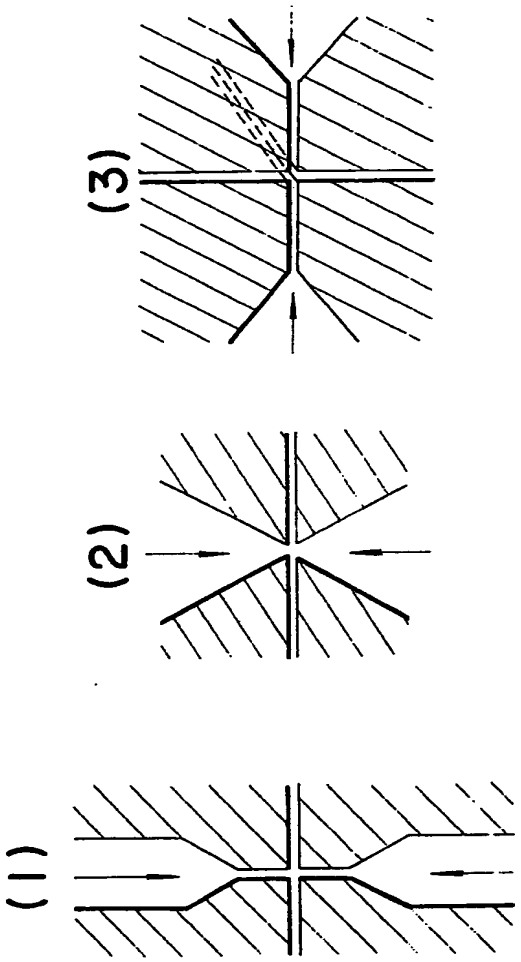
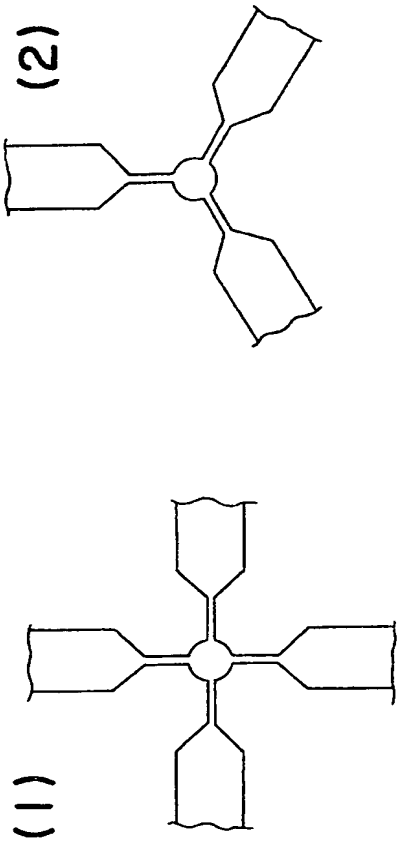


FIG. 8



SPECIFICATION

A method for dispersion

The present invention relates to a dispersing method, more in detail, to a method dispersing a kind of liquid in another kind of liquid to obtain an emulsion or dispersing powdered solid particles in a liquid to obtain a suspension.

Heretofore, a ball mill, sand grinder, high speed forced shearing disperser or colloid mill, ultrasonic disperser, and homogenizer have been used in order to obtain liquid having a high corpuscularity or emulsified liquid having a highly homogenized dispersion.

However, in any case of using said conventional methods it has hardly obtained a super fine particles dispersed substance, or a high dispersed product having few coagulation. It is also impossible to obtain super fine particles by making use of the homogenizers using standard homogenizing values as disclosed in the U.S. Patent Nos. 2,504,678; 2,242,809; 2,304,689; 2,882,025; and 2,137,854, because such homogenizers have few dispersing energy.

Therefore, such proposals have been made as the dispersing method that liquid to be dispersed is passed through a diaphragm having multistage tiny holes within a short time as described in the U.S. Patent No. 3,648,984 or, as the dispersing method that liquid to be dispersed is jetted and collided with a wall by making use of nozzle, and dispersed thereby as disclosed in U.S. Patent No. 4,124,309. But in the former method, the dispersion is made solely by shearing force receiving from a wall at the time when the liquid is passed through the diaphragm of tiny holes, therefore the satisfactory dispersibility comes into question because the dispersion energy thereof is few and the liquid in not wrenched off but is as it is. And in the latter method, the dispersion is made by jetting the liquid to be dispersed and colliding it with a wall by making use of nozzle, therefore it remains a question to put the method in practical use because the wall is seriously defaced while a large dispersion energy can be obtained.

The present invention is to provide a dispersing method and an apparatus therefor to obtain a supper fine particle dispersed substance or high dispersed product having few coagulated particles, and an object of the invention is to provide a dispersing apparatus having simple and easy-to-maintain structure and in addition, almost no wearing-out thereof and durable to use for long period of time.

The present invention comprises a step to collide a flow of liquid with the other flow of liquid, wherein each liquid may contain solid particles to be dispersed, or it may be a mixture of two kinds of liquid. Collision should be taken place when the flows are jetting at high speed. In case of dispersing liquid in other liquid, there are fundamentally two embodiments in the present invention. In one way each liquid is jetted out respectively to collide each other. In the other way a mixture of two kinds of liquid is divided into two or more flows of liquid then each flow of mixture is jetted out to collide with each other. The latter way is applied to a method to disperse fine solid particles in liquid, namely mixture of the fine solid particles and liquid to be dispersed is divided into two or more flows of liquid, then each flow of the mixture is jetted out to collide with each other. According to an embodiment of the present invention two or more flows are jetted through a plurality of nozzles to the same spot, thereby the flows are collided with each other. The orifices of a plurality of nozzles are arranged so that the exit openings is close to each other or oppose to each other at the same spot. The present invention is also to provide a dispersing apparatus of which the inner wall is not worn out and which is durable to use for long period of time. Owing to such simple structure thereof.

The following is a concentrate description of the present invention referring to an example as illustrated in the drawings attached hereto.

Fig. 1 is a sectional view of an example of the invention. In the example, taking an example of emulsification of the mixture of two kinds of liquid which are not miscible with each other, a dispersing aid is added in the mixture, and preferably, the premixed mixture is transported to a high pressure pump 1, and the mixture pressured at 10-2,000 kg/cm^2 (preferably 50-1,500 kg/cm^2) by means of the pump 1 is divided into two flows by passing through the flow holes 2, 2' and 2'', and are supplied to the nozzles 3. Said flows are forced to be extremely shrunk flows at this point whereby the liquid suffers a shearing force to be dispersed also at this spot. And, a part of high pressure energy is converted to dynamic pressure and said liquid becomes high speed fluid. The high speed fluid is then introduced to the jetting orifice 4 having a sectional area of 0.03-20 mm^2 and further dispersing action is effected by the shearing force at this part.

Thus, the preliminary dispersed mixture is jetted from the opening 5, and then after travelling one half path with the intervals of 0.3-10 mm, said mixture is collidedly dispersed on the colliding surface 6 of the jetting liquid. Thus, the collided liquid which is given a high dispersibility and is super-corpusculated thereby, is guided through a space surrounded with the walls 7 of outlet section, and then flows to the outlet orifice 8.

And, in the above case there is almost no wearing-out of the wall surface 7 of the outlet section, and it is very valuable for practical use. Fig. 2 is an enlarged view of the jetting orifice 4, exit opening 5, colliding surface of jetting liquid 6, and outlet section walls 7; Fig. 3 is a front view of the jetting orifice 4. Fig. 4 is illustrating another example of the invention; like the above, the colliding section of jetting liquid is not limited to one, but collisions can also be done at a plurality of places.

Fig. 5 is a sectional view illustrating a further example of the invention. Wherein, the dispersing unit 9 is connected one after another, and liquid is dispersed stepwise thereafter. Such a method to continuously disperse through the multistage will produce a remarkably good result in comparison with the methods that one dispersing unit is collidely dispersed repeatedly many times, such as batch sys-

tem. Such batch system cannot produce a good dispersion result, because particles will coagulate with each other when they remain in a pot, and in contrast to such a batch system, the said method can produce a superb dispersion effect because particles do not coagulate but are dispersed as they are when they pass therethrough many times. How many stages to be required are determined empirically on all such occasions as liquids vary from case to case. In order to obtain a desired despersibility, it is also possible to disperse by adjusting the number of connectives.

Further, the present invention is not only limited to the above example, but the similar effect of a flow-in mixture can also be obtained by making use of separate high pressure pumps as shown in Fig. 6. In this case, it is also possible, in emulsified dispersion of liquid in liquid, that each of different kinds of solutions is emulsified by using separate pumps to be sent presurized respectively. And, the shape of jetting orifice may not necessarily be the above embodiment as shown in Fig. 7 (1), but may be such a shape of conically narrowed orifice as shown in Fig. 7 (2), or such a shape of jetting orifice having a trapezoidal pole like nozzle and a slit from which solution is flowed into a rectangular slit as shown in Fig. 7 (3). And the flow-in from three or four directions and the like are also possible to disperse, and there is no limitiation to the number of colliding flows (jetting flows) (see Figure 8).

High flow speed at the time of collision is required to obtain the effects described above, particularly for further dispersion, 10 m/sec, or higher preferably 50 m/sec. or higher of the flow speed at a jetting orifice is required.

It should be noted that speed of flows at collision is an important meaning but pressure difference between jetting orifice 5 is more important. The pressure difference mainly depends on the sectional area of the jetting orifice and viscosity of liquid. The pressure difference may be adjusted to 10-2,000 kg/cm^2, preferably 50-1,500 kg/cm^2.

The above description relates to that crudely large liquid particles in a mixture of two kinds of liquids which are not soluble with each other are dispersed corpusculatedly and emulsifiably, and just the same facts come under the case that solid fine particles are homogenizedly dispersed in liquid.

Next, an experimental result from using of one concrete apparatus is described as follows; referring to a homogenizing dispersion of a photosensitive material, the following water phased solution and oil phased solution are jetted and the both are homogenizedly dispersed.

Water phased solution is gelatin solution containing surface active agent serving as dispersing aid:

Water
Dispersing agent
Alkanol B (alkylnaphthalene sulfonate, made by Du Pont)
Gelatin
26 parts (in cubic volume)

Oil phased solution

Solvent having a low boiling point
(ethyl acetate)
Solvent having a high boiling point
(dibutylphthalate)
Coloring agent
(1 - (2,4,6 - trichlorophenyl) - 3 - [3 - (2,4 - di - t - amylphenoxy acetyl amino)benzoylamino] - 5 - pyrazolone
10 parts (in cubic volume)

Solution of gelatin is stirred up at a constant temperature and then used, and oil phased solution is dissolved with a coloring agent at a constant temperature and then used. Those of said two solutions are premixed of which mixture is used as a sample, and said sample is dispersed separately by a ball mill, a high pressure homogenizer and a dispersing method as described in the Japanese Patent Examined Publication No. 11221/1977, and each dispersed material of which is used as the comparison sample. On the other hand, the dispersed material which is made by the dispersing method of the invention is shown in Table 1.

Table 1

Apparatus	Conditions of Experiment	Average diameter of dispersed grains
Ball mill	104 rpm 6 Hrs.	1.5 μ
High pressure homogenizer	Dispersing pressure 440kg/cm^2 Discharge from pump 1l/min	0.5 μ
Jap. Pat. Exam. Publ. No. 11221/1977	Dispersing pressure 440kg/cm^2 Discharge from pump 1l/min	0.6 μ
The invention	Dispersing pressure 440kg/cm^2 Discharge from pump 1l/min	0.2 μ

As a result shown in Table 1, it is proved the fact that the dispersion method of the present invention can keep in high dispersive state.

In addition to the above, the present invention is also effective to produce suspensions such as an uniform dispersion into zinc oxide solution.

Brief description of the Drawings

Fig. 1 is a sectional view of an example of the invention, Fig. 2 is an enlarged view of a jetting orifice and its neighborhood of the example, Fig. 3 is a front view of section of the jetting orifice and its neighborhood as shown in Fig. 2, and Figs. 4, 5, 6, 7 and 8 illustrate the other examples of the invention.

1 ... High pressure pump
2, 2' & 2" ... Flow holes
3 ... Nozzle
4 ... Jetting orifice
5 ... Exit opening
6 ... Surface being collided with sprayed solution
7 ... Wall at outlet section
8 ... Outlet
9 ... Dispersion unit

CLAIMS

1. A method of dispersing liquid or solid particles in a different liquid which comprises causing a flow of the said different liquid to collide with a flow of the first liquid or a liquid containing said solid particles.

2. A method according to claim 1 wherein a liquid containing solid particles or a different liquid is separated into two separate liquid flows which are caused to collide.

3. A method according to claim 1 or 2 wherein the two flows are substantially parallel.

4. A method according to any one of claims 1 to 3 wherein each flow is jetted through an orifice to a point where the two flows collide.

5. A method according to claim 4 wherein the pressure differential across the orifice is 50 to 1,500 kg/cm^2.

6. A method according to any one of the preceding claims wherein the flow rate of each flow is at least 50 m/sec.

7. A method according to any one of the preceding claims for obtaining a dispersion of a photosensitive material.

8. A method according to claim 1 substantially as described in the experiment.

9. A dispersion of a liquid or solid in a liquid whenever obtained by a method as claimed in any one of the preceding claims.

10. Apparatus suitable for use in a method as claimed in claim 2 which comprises an inlet for the liquid, means for separating the liquid into two channels, said channels terminating in two orifices, said orifices being axially opposed to one another with an axial space there between, said axial space being provided with an outlet for the liquid.

11. Apparatus according to claim 10 wherein said axial space is als provided with a recess opposite said utlet.

12. Apparatus according to claim 10 or 11 wherein each channel is provided with walls which converge to its orifice.

13. Apparatus acc rding t claim 10 or 11 wherein each channel is connected to its orifice by a channel of the same diameter as its rifice, said diameter being smaller than the diameter f the first said channel.

14. Apparatus according to any one of claims 10 to 13 wherein the inlet is connected to a pump.

15. Apparatus according to any one of claims 10 to 14 wherein the outlet is connected to the inlet of another said apparatus.

16. Apparatus according to claim 10 substantially as described in Figure 1 of the accompanying drawings.

17. Apparatus according to claim 10 substantially as described in Figure 7 (2) or (3) of the accompanying drawings.

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